

Mobile Broadband Penetration and Poverty reduction: The case of selected countries in sub-Saharan Africa

Paul Terna Gbahabo and MccPowell Fombang

Stellenbosch University, Cape Town South Africa

Abstract

This paper studies the relationship between broadband penetration and Human welfare (or poverty reduction) in selected countries in sub-Saharan Africa. Using the externalities effect of Endogenous Growth Model, we employ Generalized Method of Moments (GMM) dynamic instrumental variable modelling approach to panel data spanning 16 countries for a period of 17 years (2000-2016) to estimate the welfare effect of internet broadband. Data was collected from various sources including World Development Indicators, International Telecommunication Union and the United Nations Development Program. The a priori expectation is that mobile broadband is positively associated with economic growth and welfare in sub-Saharan Africa. The a priori expectation is that there is a positive association between internet broadband penetration and poverty reduction in sub-Saharan Africa. We also expect to find significant differences among countries in the region with internet broadband expected to have an even greater welfare effect on lower income countries than on upper middle-income countries. The findings of this study will have wide ranging implications for policy, practice and further research.

Keywords: Mobile Broadband, Poverty reduction, Sub-Saharan Africa

JEL Codes:

1. INTRODUCTION

There is a growing recognition of the transformational role broadband internet play in enabling social inclusion and economic well-being among academics and policy makers around world (UNDP, 2016; 2001; World Bank, 2016; UN, 2016). The United Nations and the World Bank have both identified broadband internet as very crucial in empowering people, lifting people of poverty through job creation, and creating conducive environment for business and technological innovation as well as enabling developing countries to achieve structural transformation and social inclusion. This growing recognition of the economic impact of broadband internet penetration has spurred massive investment and deployment of broadband infrastructure in both developed and developing countries over the last decade (Minges, 2015).

Broadband internet deployment in most developing countries have witnessed unprecedented rapid growth in the last decades due to a number of factors such as better privatization and trade liberalization policies as well as advances in telecommunication technology giving rise to lower network installation cost and greater service affordability (GSMA, 2010; Minges, 2015). The scale of diffusion of broadband technology, particularly mobile internet and the transformational effect it continues to have across all sectors of the economy in enabling the creation of new business processes/product innovation thereby

boosting job creation, consumer surplus as well as raising economic growth and productivity suggest that the broadband internet is a general purpose technology capable of producing a protracted critical mass effect at certain threshold of penetration (Bresnahan and Trajtenberg, 1995; Koutroumpis, 2009).

Investments in broadband infrastructure and its corresponding adoption has witnessed a steady growth rate in sub-Saharan Africa over the last two decades following telecommunications reforms introduced in the mid-1990s (Gillwald, et al 2012).

In spite of the growing recognition of broadband internet as a critical enabler in an increasingly connected world by policymakers and researchers, a thorough survey of extant literature reveals that there is paucity of empirical studies on the socio economic long-term effect of broadband internet penetration on socioeconomic inclusion in sub-Saharan Africa in general and Southern Africa region in particular (Minges, 2015). Out of the few studies that have focused on investigating the social economic effect of broadband internet in South Africa, some of them have either been cross-country panel studies (Deloitte, 2011) or country-specific time series studies (Salahuddin and Gow, 2015) that employed national aggregate data. Thus far, no empirical panel study has been carried out to provide an in-depth understand of the social welfare effect of broadband internet penetration on human development.

Statement of research problem

The evolution and proliferation of broadband internet technology around the world has ushered in new perspectives in long term growth in human welfare analysis. This has led to a new wave of research interest in the role broadband play in stimulating productivity and social inclusion. This is borne out of the transformative influence of the rapidly expanding broadband telecommunication networks in creating jobs, increasing access to financial services, reducing transaction cost and information asymmetry thus improving market efficiency and reducing poverty and inequality (Thompson and Garbacz, 2007; ITU, 2012; Minges, 2015; World Bank, 2016).

In spite of the growing use of broadband internet in Sub Saharan Africa, a thorough survey of extant literature reveals that very little is known about the welfare effect of broadband internet penetration (ITU, 2012; Prieger, 2013; Minges, 2015; World Bank, 2016). In fact, there seem to be paucity of empirical studies on the impact of broadband internet penetration on socioeconomic inclusion and economic well-being in sub-Saharan Africa in general due to data limitation (Minges, 2015). Out of the few panel studies that have focused on investigating the social economic effect of broadband internet, most of them tend to focus developed countries such as European countries and the US (Koutroumpis, 2009; Czernich, et al 2011). A few time series country-specific studies focusing on sub-Saharan African countries include Katz (2009) and Salahuddin and Gow (2015). Thus far, no empirical panel study has been carried out to provide an in-depth understand of the social welfare effect of broadband internet

penetration in SADC in the region. Therefore, this study is borne out of the desire to fill this all-important research gap and makes contribution to scientific knowledge in this regard.

The rest of the work is structured as follows: Section two presents some stylized facts about the telecommunication sector in Sub Saharan Africa. The theoretical and empirical literature is discussed in section three. Section four presents the data and empirical methods employed in the study. Section five presents the results and discusses them while chapter six presents the key findings and recommendations.

2. LITERATURE REVIEW: Theoretical Framework

Theoretical linkages between technological externalities and economic growth have a long tradition stretching as far back as the magnum opus of Adam Smith in 1776. Since then, a number of other classic in the field of economics such as Marx (1867), Schumpeter (1942), Solow (1957), Romer (1986), Lucas (1988) and more recently Barro (1991) have put forward several theoretical frameworks and endogenous growth models that emphasizes on the central role of technological progress and externalities in enhancing the total factor productivity and thus economic growth under several varying assumptions.

Smith (1776) hypothesized that increase in productivity is not only a precondition for convergence in endogenous growth amongst nations but also a consequence of technological progress resulting from capital accumulation and division of labour to increased specialisation. Marx (op. cit.) stressed the need for every society to improve their forces of production by complementing human labour and organisational skills with the use of ever-changing technological innovations to achieve greater efficiency and productivity with the ultimate aim of improving the living conditions of the working class. He emphasized the economic importance of developing transportation and communication technology which he believed was essential to productivity growth.

2.2.1 Endogenous Growth Model

More than any other theory, the endogenous growth model best explains the broadband internet-welfare nexus as a contributory factor to economic growth due to its emphasis on endogenous technological change and networked externalities or spill-over effects on the economy. The multiplier effects of networked externalities or spill-over effects do stimulate increasing social returns which consequently stimulates sustained economic growth. The most important innovation in the endogenous growth model over the Solow model was suggested by Paul Romer (1986) who not only emphasized the endogeneity

of the productivity function and its implication on economic growth but also the ability of capital to enjoy an increasing return to scale depending on the scale of net investment employed. In other words, growth is a function of investments in physical and human capital resulting from a profit-maximising agent's deliberate decisions. Similarly, Lucas (1988), Grossman and Helpman (1991) also contributed in developing and testing the endogenous growth model known as New Growth Theory.

The model adopted for this theoretical framework is a simple AK endogenous growth model based on aggregate production function with technology,

$$Y_t = A(K_t)$$

Where Y_t represents real aggregate output of goods and services in the economy, and K_t represents a broad aggregate measure of capital stock (physical capital, human capital and public infrastructure) in the economy, and A_t represents endogenous technical change ($A > 0$). Capital ($K_t = \infty$) assumes an increasing return to scale depending on the level of net investment employed (Barro and Sala-i-Martin, 1991).

2.6. EMPIRICAL LITERATURE

The empirical evidence in the literature that sought to establish the relationship between broadband internet and socioeconomic well-being appears to be largely conclusive and can be organised into two categories; empirical panel studies which constitute the overwhelming number of studies (see e.g., Crandall, Lehr and Litan, 2007; Qiang and Rossotto, 2009; Koutroumpis, 2009; Katz et al, 2010 for instance), and time-series empirical studies which are quite few due data availability constraint (see e.g., Katz and Koutroumpis, 2012a; 2012b; 2012c; Salahuddin and Gow, 2015).

2.6.1 Empirical panel studies

Empirical panel studies can be generally classified into panel studies using household data (Kolko, 2011; Katz and Callorda, 2013) and panel studies focussing on subnational administrative units within countries (Ford and Koutsky, 2005; Gillett, Osorio and Lehr, 2006; Crandall, Lehr and Litan, 2007; Katz, Vaterlaus, Zenhäusern, and Suter, 2010; Atasoy, 2013; Feng and Ma, 2013; Whitacre, Gallardo and Strover, 2014) as well as cross-country panel studies (Qiang and Rossotto, 2009; Koutroumpis, 2009; Katz and Avila, 2010; Czernich, Falck, Kretschmer, and Woessmann 2011; Thompson and Garbacz, 2011).

The seminal work of Kolko (2011) is amongst the very few studies that employed household data in assessing the effect of broadband availability on the household welfare indicators such as earnings, and employment rate in local communities. The study employed OLS on a survey of 60,000–100,000 households in the United States of America (U.S) covering the period from 1999 to 2006. The findings

of the study suggest a positive relationship between broadband expansion and local economic growth. This relationship is stronger in industries that rely more on information technology and in areas with lower population densities. In a similar vein, Katz and Callorda (2013) using a panel of Ecuadorian household survey data comprising 24,028 observations for 3 years (2009-2011) find that the presence of broadband in a household would lead to an increase in annual income by 3.67%.

Regarding empirical evidence focussing on subnational and municipal administrative units, the work of Ford and Koutsky (2005) is one of the pioneering panel studies to measure the growth effect of broadband infrastructure in local counties in the United States of America (U.S). The study was carried out using the Seemingly Unrelated Regression on data obtained from 8 counties from the state of Florida in the United States over a 7-year period spanning between 1998-2004 and found that broadband infrastructure can be a significant contributor to economic growth in local communities. Similarly, Gillett et al (2006) also empirically investigated the economic impact of broadband in local communities between the period 1998-2002 using a set of panel data spanning several communities across the U.S. (delineated by zip code) with Pooled Ordinary Least Square (OLS). The findings reveal a positive effect of broadband on property values and entrepreneurship. Specifically, the result also shows that broadband internet penetration adds around 1% to 1.4% to employment growth in period 1998-2002. Crandall, Lehr and Litan (2007) carried out one of the most influential study on the growth effect of broadband telecommunication infrastructure in rural areas covering 48 lower states in the U.S between 2003 and 2005 with the aid Generalized Method of Moments and OLS. Their findings suggest a positive association between broadband use and an increase in nonfarm private employment and several industrial employments in rural areas. Furthermore, a study by Katz, Vaterlaus, Zenhäusern, and Suter (2009) estimated the economic effect of broadband penetration in 424 county level administrative units across Germany. The author found a positive effect, suggesting that a 10% increase in broadband penetration leads to 0.255% rise in GDP growth. Similarly, Atasoy (2013) using OLS regression with time fixed effects on a panel of 3116 county level data for a 9-year period in the U.S, analyzes the effect of broadband expansion on labour market outcomes and the result suggests that broadband adoption in a county is associated with approximately a 1.8 percentage point increase in the employment rate, with larger effects in rural and isolated areas.

Furthermore, another set of panel studies on the link between internet broadband and economic growth are cross-country empirical studies, which are perhaps the most common due to the ease of data availability. Qiang and Rossotto (2009) employed a panel of 120 countries to assess the growth effect of various ICT components including fixed broadband and mobile subscriptions for the period between 1980 and 2006. The study found that a 10% rise in broadband penetration would lead to 1.38% increase in developing economies' GDP growth. This view is corroborated in another cross-country panel study comprising 22 OECD countries over a 7-year period covering 2002-2007 by Koutroumpis. The study reports a significant and positive causal effect at certain critical mass (Koutroumpis,2009). Katz and

Avila (2010), examined the economic impact broadband and associated regulatory policies on the development of the technology in a panel study of 19 Latin American countries using quarterly data. The findings suggest that broadband contributes to GDP growth in Latin America: an increase in broadband penetration by 1 percentage point can generate GDP growth by a corresponding 0.0178 percentage points. The results also show that broadband contributes to the creation of jobs: 1 percentage point increase in broadband penetration results in an increase of 0.18 points in the occupation rate. Similarly, Czernich, Falck, Kretschmer, and Woessmann (2011) reinforces the growth effect of broadband penetration on GDP per capita growth by revisiting the hypothesis in 25 OECD countries. They found that a 10% increase in broadband penetration leads to GDP per capital growth of between 0.9 and 1.5 percentage point. Additionally, Mehmood and Mustafa (2014) analysed the impact of broadband subscription and economic growth using a panel of 24 Asian countries over 11-year period and made findings that also suggest a positive effect of broadband subscription rate on economic growth.

2.6.2 Empirical time-series studies

Empirical evidence on the link between internet broadband and economic development using time-series data are quite few and far between due to data availability constraint (Minges, 2015). For reliability, time-series econometric analysis requires a minimum of 30 observations, many countries especially in the developing regions of the world do not have such amount of data (Minges, op. cit.).

Most of the few studies in this regard are carried out by Katz and Koutroumpis on a number of countries using quarterly data in order to bridge the data gap. Katz and Koutroumpis (2012a), using quarterly time series data for Panama for the period 2000- 2010, found that 10% increase in fixed broadband penetration would boost GDP growth by 0.45%. This view is reinforced with further evidence from the Philippines by Katz and Koutroumpis (2012b). The study also employed time series quarterly data from 2001 to 2010 to analyse the economic impact of both fixed broadband penetration and concluded that there is no significant growth impact for fixed broadband however found that a 10% increase in mobile broadband penetration would lead to 0.32% increase in GDP growth in the Philippines. In a similar vein, in what is perhaps one of the earliest studies estimating the effects of internet adoption on aggregate economic growth coming from sub-Saharan Africa, Katz and Koutroumpis (2012c) using Senegalese quarterly data from 2004 to 2011. The study finds a negative and statistically insignificant effect for fixed broadband however the result also shows that a 10% increase in a simple 2G mobile phone penetration has GDP growth effect of 0.44%. Recently, Salahuddin and Gow, (2015) provided empirical evidence from South Africa that also buttresses the economic impact of internet broadband. They employed econometric analysis using both ARDL and Dynamic OLS and both test suggest a positive and significant long run relationship between Internet adoption and economic growth.

In summary, empirical evidence on the economic impact of internet broadband have been conclusive both with the use of longitudinal as well as time series aggregate data. This current study contributes to the literature by examining a broad range of socioeconomic effect of internet broadband on well-being of South Africa by using subnational data obtained at the provincial level, which are often ignored in most empirical studies.

METHODOLOGY

A critical review of the literature reveals that a growth accounting framework as adopted by Barro (1991) is the best methodology in estimating the aggregate impact of broadband internet penetration on economic well-being. Therefore, in this section we present the data variables used in the study as well as its sources. This section also states the model specification of the study and estimation technique used in carrying out the study as well as methodological issues

3.2 Data collection

Extant literature suggests the use of broadband internet subscription per 100 people as the main variable of interest and well-being/welfare (proxy by human development index, employment and GDP per capita) as the dependent variable (OECD, 2011; Gohou and Soumare, 2012; de Haan, 2015; UNDP, 2016) as well as other determinants of economic growth such as stock of physical capital, stock of human capital proxy by education, labour stock, population growth, initial level of development, and financial development as control variables (Qiang and Rossotto, 2011).

3.3 Data sources and scope

The data for this study spans the period between 2000 to 2014 and is obtained from the World Bank's World Development Indicators (WDI). The following are the dataset to be employed in this study: Economic well-being is measured as the log-change in human development index; Broadband internet penetration is measured as broadband internet subscription per 100 people is taken as the log of annual growth rate in mobile broadband users per 100; Physical capital stock is the stock of fixed infrastructure and equipment in the economy and is measured by the log-change of gross fixed capital formation as a percentage of GDP; Human capital is the stock of educational skills and knowledge acquisition in an economy and is measured by the log of level of secondary education in the country; Growth in labour stock is the annual percentage change of the total population of working age participating in the economy denoted as the log-change of labour-force; Population growth rate is the average growth rate for the duration of the study measured as log of annual percentage changes; Financial depth measures the level of financial depth of the province expressed as log-change of credit to the private sector as percentage of GDP.

Table 3.1 Variables employed to measure the effect of Broadband Internet on Economic Growth and sources.

Variable	Data Series for the period 2002Q1-2016Q4	Sources	Data frequency	Rationale	A priori expectation
Economic well-being	Human Development Index	UNDP	Annually	Dependent variable	$\beta > 0$
Broadband internet Penetration	Broadband internet Subscription per 100	Statistics SA, ICASA	Annually	Variable of interest	$\beta > 0$
Financial depth	Private credit to province	South A Reserve Bank	Annually	Control variable	$\beta > 0$
Physical stock of capital	Gross fixed capital formation as a share of GDP	Statistics SA	Annually	Control variable	$\beta > 0$
Labour stock	Labour force participation	Statistics SA	Annually	Control variable	$\beta > 0$
Human Capital	Adult Literacy as a percentage of total population	UNESCO Statistics	Annually	Control variable	$\beta > 0$

3.5 Estimation Method

We employ the Generalized Method of Moments. The literature has identified the system Generalized Method of Moments as the most frequently used estimation method in carrying out endogenous technical change growth accounting test in panel studies due to its enormous advantages. Some of the advantages that GMM estimation offers include its ability to control for both endogeneity and bidirectional causality as well as correct for serial correlation in order to obtain a more efficient estimation. The GMM is also suitable for estimation when the study period is small (Andrianaivo and Kpodar, 2011; Waverman, Meschi and Fuss, 2005). To overcome the problem of weak instrument estimation that has been identified as one of the weaknesses of GMM as well as to check for robustness of the estimation method, we conduct two validity tests. The Hansen-Sargan test of overidentifying restrictions as well as the Arellano-Bond test for serial correlation of the residuals (Waverman, Meschi and Fuss, 2005).

To further understand the welfare effect of broadband internet on the various income groups amongst the population, following the examples of Abadie, Angrist and Imbens (2002) and Gomanee and Gima (2005) we also employ quantile regression which enables us to disaggregate the data into several median groups so as to capture the welfare effect of broadband internet on the several quantiles.

It is important to note that in order to avoid spurious regression problems, all data variables employed in the study are expressed in their logarithmic form and only the percentage changes of the logged series of each variable is utilized. The proxy for human capital employed in this study is number of pupils in secondary school education as many studies have emphasized the weakness of primary enrollment and completion as a proxy for human capital (Deloitte and GSMA, 2011).

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